Cooperative Institute for Atmospheric Sciences and Terrestrial Applications (CIASTA)

ANNUAL REPORT
NOAA Cooperative Agreement NA17RJ1222
July 1, 2004 – June 30, 2005

Prepared by:
Mark Green, Director
Division of Atmospheric Sciences
Desert Research Institute

2215 Raggio Parkway, Reno, Nevada 89512-1095
Phone (775) 673-7300 Fax (775) 673-7397

755 E. Flamingo Road, Las Vegas, Nevada 89119-7363
Phone (702) 862-5400 Fax (702) 862-5496

TABLE OF CONTENTS

ANNUAL PERFORMANCE REPORT
JULY 1, 2004 TO JUNE 30, 2005

I. Introduction

A. CIASTA MISSION

The Cooperative Institute for Atmospheric Sciences and Terrestrial Applications was formalized with the signing in early 1995 of a Memorandum of Understanding (MOU) between the National Oceanic and Atmospheric Administration (NOAA) (Administrator D. James Baker, signatory), represented by the Office of Oceanic and Atmospheric Research; the National Weather Service; the National Environmental Satellite, Data, and Information Service; and the University and Community College System of Nevada (Chancellor Richard S. Jarvis, signatory), represented by the Desert Research Institute (DRI).

The CIASTA will carry out a number of activities, including, but not limited to:

- *Foster long-term collaborative research on themes of mutual interest.*
- *Facilitate the establishment of joint research projects between scientists of NOAA and universities in the Intermountain West (Rocky Mountains to the Sierra Nevada/Cascade Mountains).*
- *Improve the effectiveness of graduate-level education and expand the scientific experiences available to graduate students to include their participation in joint research programs with NOAA.*
- *Serve as a focal point for the interaction between NOAA and the Intermountain West research community for research activities related to NOAA's tasks and responsibilities in that region.*
- *Provide the mechanism to develop a major, multi-sponsor program for the Intermountain West in weather research, climate research and services, air quality research, and terrestrial studies.*

The work of the CIASTA is organized into five tasks:

- *Task I.* Administration and Visiting Fellows Program
- *Task II.* Weather Research
- *Task III.* Climate Research and Services
- *Task IV.* Air Quality Research
- *Task V.* Terrestrial Ecosystems and Climate

The NOAA host laboratory for CIASTA is the Air Resources Laboratory (ARL).

According to the MOU, CIASTA is administered through DRI and the CIASTA Director is employed by DRI.

To illustrate the niche that CIASTA occupies, it is illustrative to describe CIASTA's relationship to the Desert Research Institute (DRI) and the University and Community College System of Nevada (UCCSN). CIASTA is managed as a center within the Desert Research Institute. The part-time director and administrator of CIASTA are employees of Desert Research Institute. For most projects funded through CIASTA, the Principal Investigators have been DRI employees, although a UNLV professor has also been a PI on CIASTA projects.

Overview of Desert Research Institute

In 1959, the Nevada State Legislature created a division of the University of Nevada specifically devoted to conducting research. This division became the Desert Research Institute.

DRI's Mission statement is as follows:

> *We excel in environmental research and the application of technologies to improve people's lives throughout Nevada and the world. We implement this mission by fostering scientific talent for the advancement and integration of terrestrial, hydrologic, atmospheric, and anthropologic sciences. We apply scientific understanding to the effective management of all natural resources while meeting Nevada's needs for economic diversification and science-based educational opportunities.*

DRI consists of 3 Divisions: the Division of Atmospheric Science, the Division of Hydrologic Sciences, and the Division of Earth and Ecosystem Sciences. In addition, there are 3 interdisciplinary Centers: the Center for Arid Lands Environmental Management, the Center for Wetlands and Environmental Sustainability, and the Center for Environmental Remediation and Modeling. An organizational chart for DRI is shown below. In the management structure, CIASTA is treated essentially as a center, with the CIASTA director reporting to the Vice-President for Research for the CIASTA portion of his position (approximately1/2 time if provided sufficient funding). For the other half-time, as a Research Professor in the Division of Atmospheric Sciences, the CIASTA director reports to the Executive Director of that division.

DRI employs over 400 faculty, staff, and students. DRI's research revenue for FY 2003 (July 2002-June 2003) was $28.3 million. Federal grants and contracts were responsible for 78% of DRI's operating revenues for FY 2003. DRI is responsible for administering and teaching the Atmospheric Science Graduate program at the University of Nevada-Reno and administers and teaches in the Water Resources Management Program at the University of Nevada –Las Vegas. DRI faculty are also teaching science classes at Nevada State College in Henderson.

B. CIASTA ACTIVITIES

August 3, 2004: Coordination Meeting on Meteorological Monitoring and Modeling in Southern Nevada. Hosted by the Cooperative Institute for Atmospheric Sciences and Terrestrial Applications at the Desert Research Institute, 755 E. Flamingo Road, Las Vegas Nevada

The purpose of the meeting was to address mesoscale and urban scale meteorological data needed to support atmospheric modeling, data analysis, air quality research and emergency response activities in southern Nevada. The goal of the meeting was to improve coordination among agencies and organizations making these measurements to optimize their use for:

- Air quality assessment and modeling, in particular for tropospheric ozone and surface releases of hazardous materials in support of public health and safety
- Improved weather forecasting on local and regional scales, including a variety of severe weather, i.e. severe thunderstorms and flash flooding, in support of public safety
- Local scale transport and dispersion in support of homeland security

Additional background information is contained in the meeting invitation document .
The meeting was attended by 31 participants from 11 organizations including:

National Oceanic and Atmospheric Administration Air Resources Laboratory (9)
Desert Research Institute/CIASTA (4)
Clark County Dept. of Air Quality and Environmental Management (5)
University of Nevada- Las Vegas (4)
US Geological Survey (2)
T & B Systems (2)
Argonne National laboratory (1)
Bureau of Land Management (1)
Clark County Regional Flood Control District (1)
USEPA (1)
Congressman Jim Gibbons' office (1)

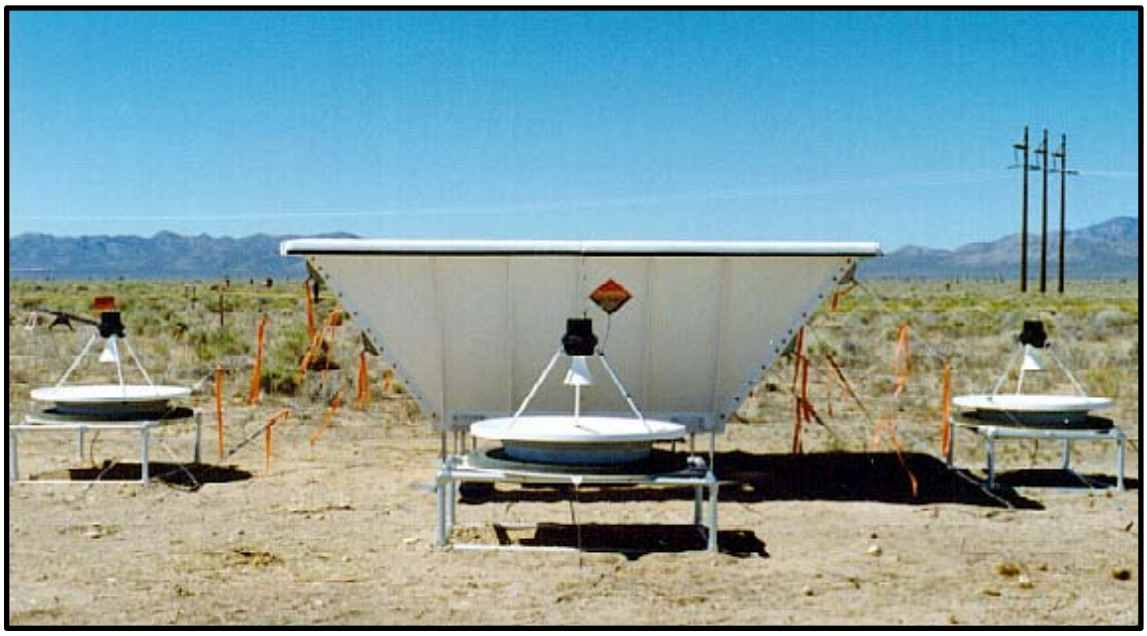
INTRODUCTION
The meeting began with an introduction by Mark Green, CIASTA Director. He outlined the purpose and goals of the meeting. The introductory talk was followed by a self-introduction of all participants.

NOAA-ARL SORD
Darryl Randerson, Director, NOAA- ARL Special Operations and Research Division (SORD), Las Vegas described meteorological activities undertaken by SORD in southern Nevada. SORD conducts basic and applied research on problems of mutual interest to National Oceanic and Atmospheric Administration (NOAA) and Department of Energy (DOE) that relate to the Nevada Test Site (NTS), its atmospheric environment, and its emergency preparedness and emergency response activities.

SORD operates and maintains a meteorological monitoring network and has implemented a mesoscale meteorological prediction model for southern Nevada, mainly in support of DOE/National Nuclear Security Administration (NNSA) activities at the Nevada Test Site (NTS). The NTS monitoring system includes a network 30 meteorological towers, two radar wind profilers for vertical profiles of wind speed and direction, and temperature, a lightning detection network, and twice daily radiosonde releases for vertical profiles of pressure, temperature, relative humidity, wind speed and direction. ARL supports meteorological modeling for southern Nevada by running the Regional Atmospheric Modeling System (RAMS) daily at the UNLV supercomputing center. This activity includes running the RAMS model at high resolution (to 2-km grid spacing) over southern Nevada, including the Las Vegas Valley (add link to Randerson's presentation).

NTS VERTICAL PROFILERS

(YUCCA FLAT – BJY, FRENCHMAN FLAT – HSC)

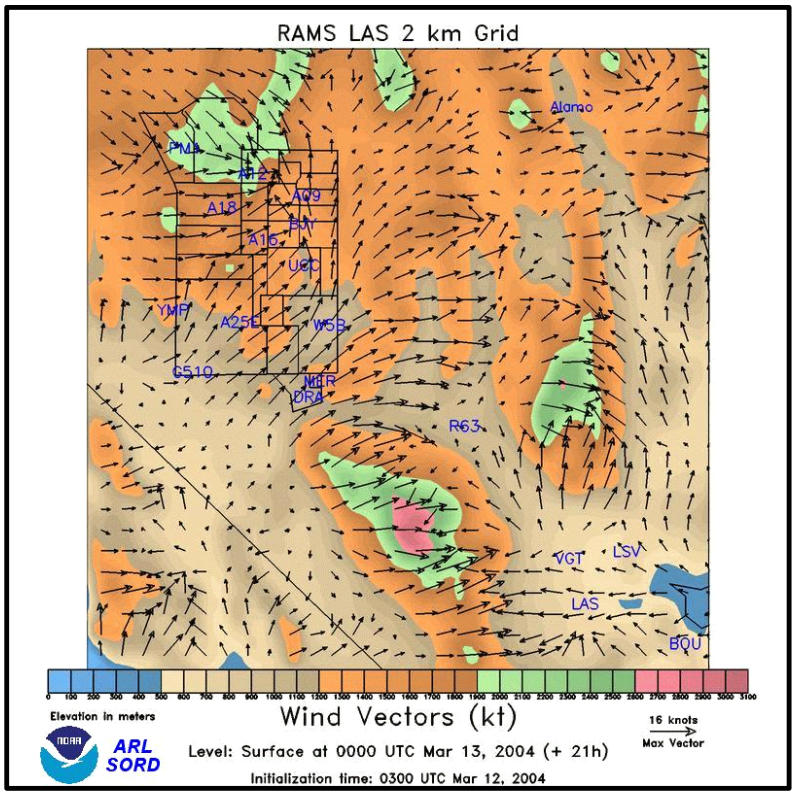


The RAMS model frequently predicts small-scale surface-level convergence zones across the Las Vegas Valley. These areas could be associated with enhanced thunderstorm development and heavy precipitation. It would be of interest to see if measurements support these model results.

ARL has been providing support for this summers' North American Monsoon Experiment (NAME). This includes additional upper air soundings at Desert Rock.

REGIONAL SCALE ATMOSPHERIC PREDICTION MODEL (RAMS)

- **PREDICTIONS TO 33 HOURS**
- **RUN DAILY ON NOAA 00Z/12Z DATA**
- **USE OF UNLV SUPER COMPUTER**
- **OUTPUTS ON SORD WEBSITE**



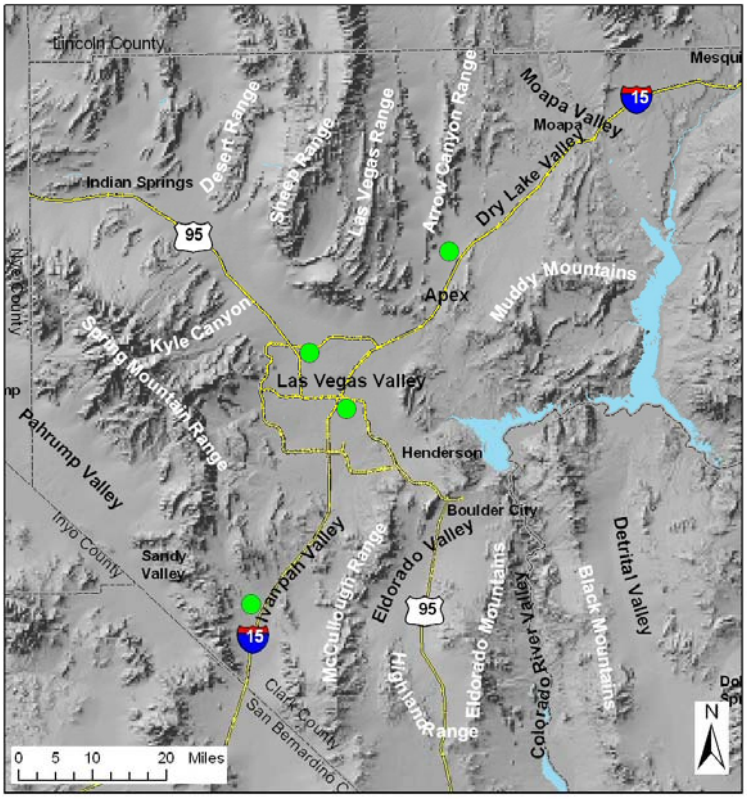
CIASTA

Mark Green presented an overview of the Las Vegas area upper air monitoring project. The study, sponsored by Clark County, is being conducted by CIASTA with DRI NOAA-SORD participants. A major goal of the study is to better understand 3 dimensional wind patterns in southern Nevada and how they affect transport of ozone and precursors. One radar wind profiler and four SODARS will be purchased and deployed in time for the 2005 ozone season. The radar wind profiler will be located in the central Las Vegas Valley. A "mini-SODAR" will be collocated with the radar to better define low level (<150 m). The other three SODARs will be located in areas to help define transport pathways to and from areas outside of the Las Vegas Valley. Likely locations include:

- Southwest of Las Vegas near Jean, NV
- Northeast of Las Vegas near Apex, NV
- Northwestern portion of the Las Vegas Valley

ARL-SORD will release radiosondes and pilot balloons (pibals) at key locations on a forecast basis (high ozone conditions expected) during summer 2005 to help understand slope and reversal flows, especially in western portions of the Las Vegas Valley.
Data from the National Weather Service WSR-88D radars southeast of Las Vegas, at Edwards AFB, and Yuma will be processed to obtain regional upper level winds.

A database of summer 2005 data will be compiled and some interpretation of the data will be performed. The dataset could be used for meteorological modeling and subsequent air quality (i.e. ozone) modeling. Clark County DAQEM personnel will be trained for continued operation of the instruments.



Potential upper air monitoring locations

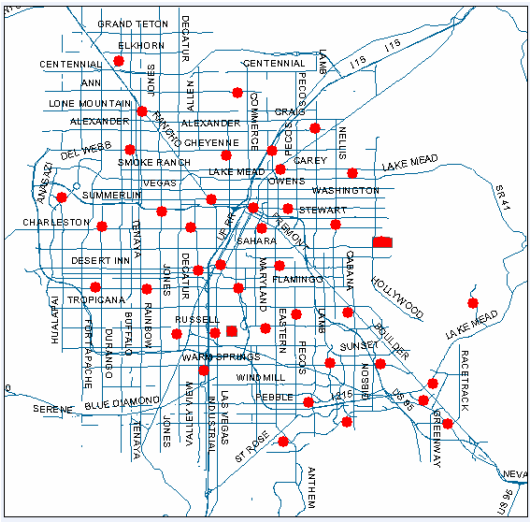
It is hoped that the radar wind profiler data would be used by the National Centers for Environmental Prediction (NCEP) for input to their weather forecasting models. Coordination with NCEP will be established to facilitate their use of the data.

UNLV- National Center for Advanced Computational Methods (NCACM)

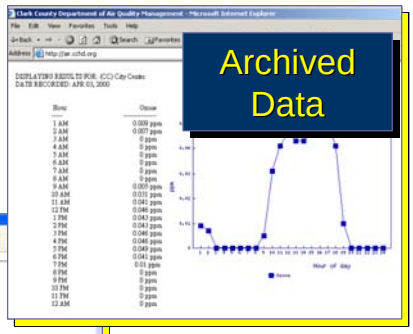
Darrel Pepper discussed a real-time emergency response modeling system under development. He proposed a network of meteorological towers on top of fire stations in the Las Vegas Valley. The fire stations are nearly equally spaced with good coverage of the valley and would be a boon to obtaining good wind fields for transport and dispersion modeling. First-time responders could run the models on desktop computers or laptop computers or PDA's in the field. The codes are under development. UNLV has been collecting and displaying data from City and Clark County agencies for several years.

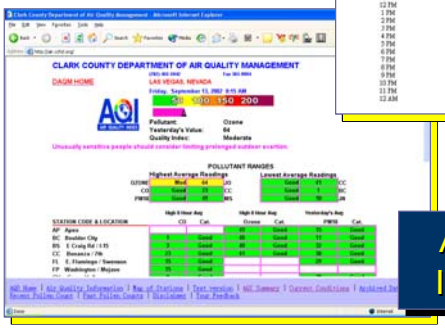
Yitung Chen and Sean Hsieh discussed their program for archival and real-time display of data from the Clark County Dept. of Air Quality and Environmental Management. Air quality and meteorological data back to 1996 can be obtained from www.ccairquality.org.

Las Vegas Fire station map



Web-based Data Management



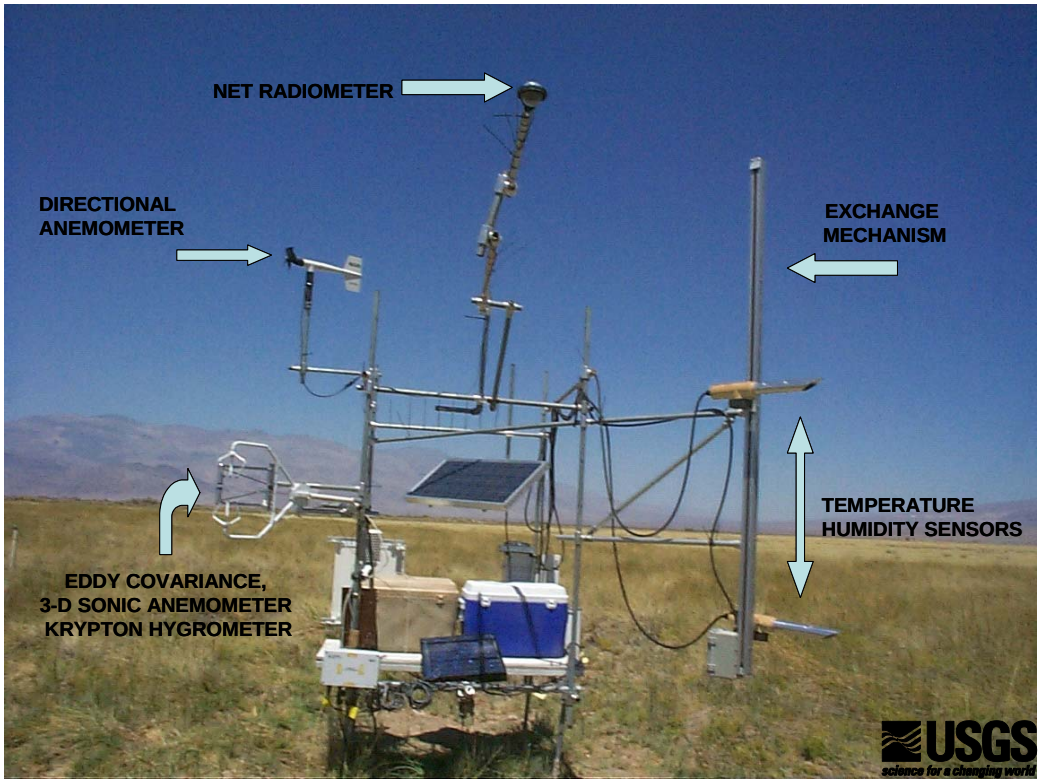


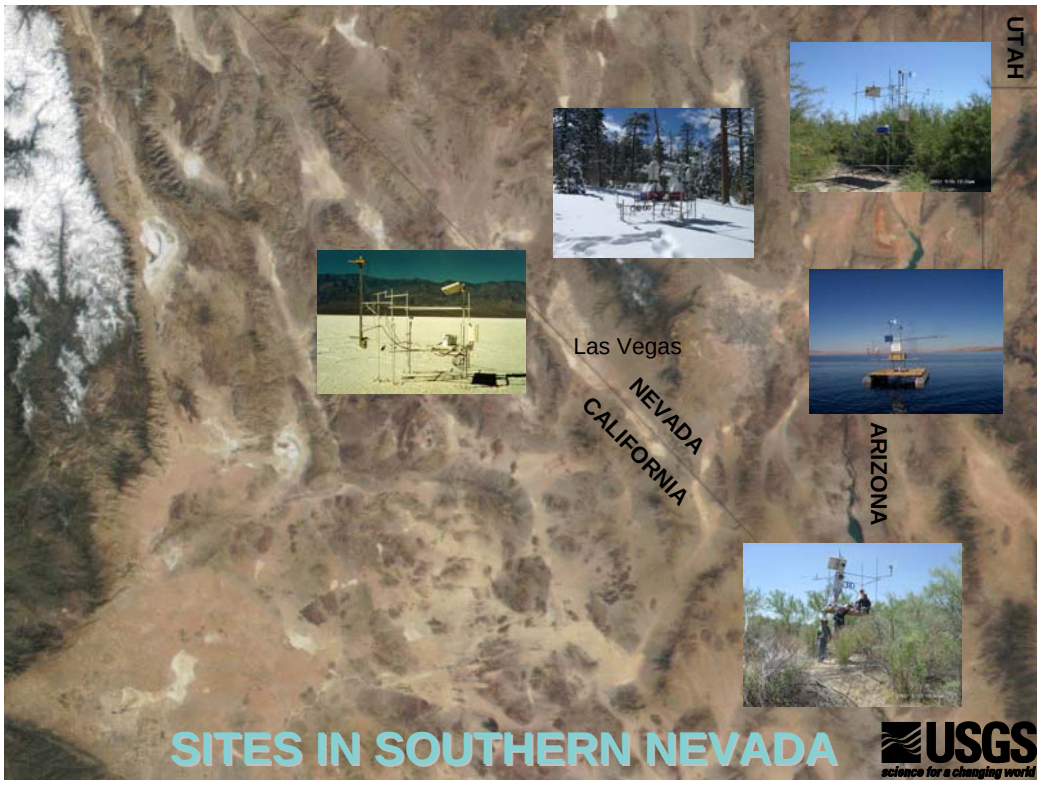
http://www.ccairquality.org

USGS

Guy DeMeo described surface energy budget measurements by USGS in southern Nevada. USGS is especially interested in latent heat flux. Measured or derived parameters include temperature, relative humidity, soil temp, net radiation (net radiometer), heat flux, eddy flux, Bowen ratio, and wind from sonic anemometers.

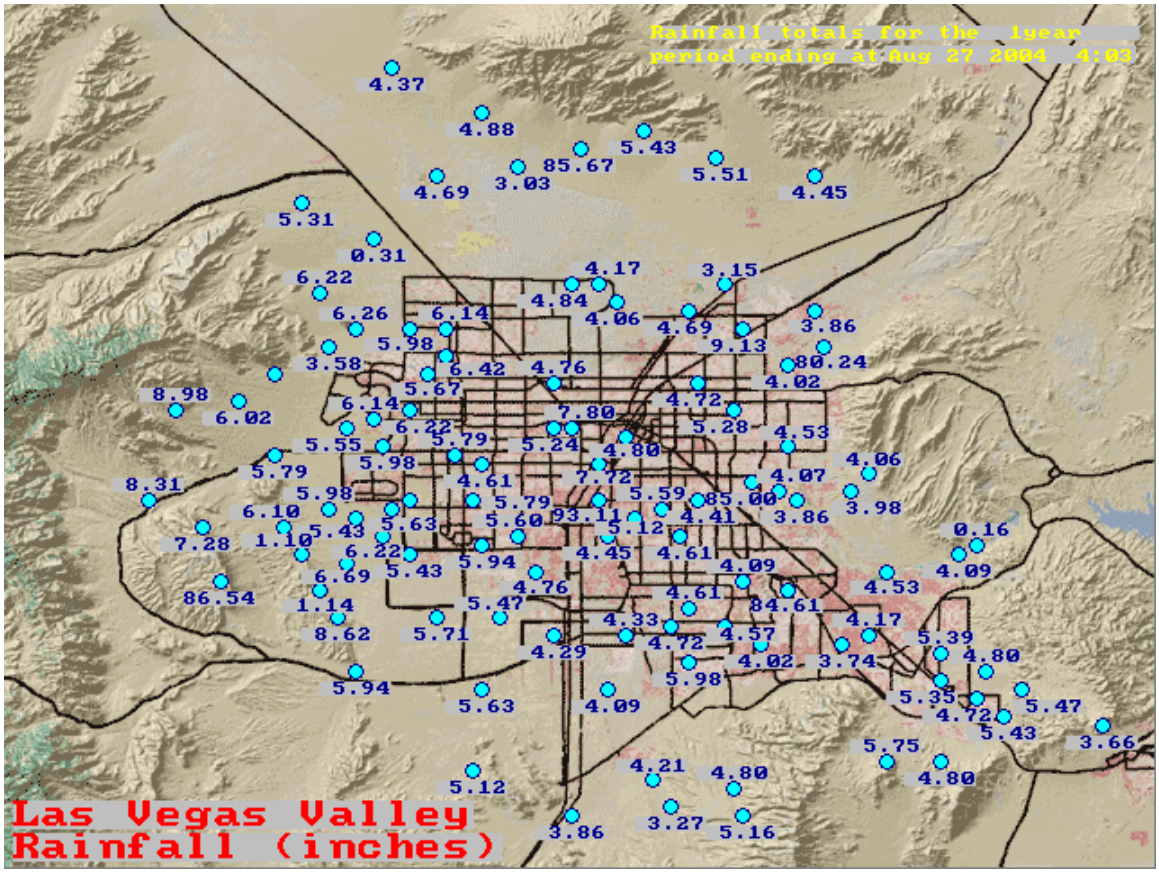
Typically monitoring is done 2-3 years at a site. Current sites include: Lee Canyon, Nevada Test Site (2 locations), Lake Mead, and Moapa. Long-term monitoring is desired. A transect of about 20 stations across the Spring Mountains and Sheep Range for a life zone study is proposed.





Clark County Regional Flood Control District

Tim Sutco described the Clark County Regional Flood Control district monitoring network. There are 138 field sites, 106 of which are in the Las Vegas Valley. 24 have wind speed, wind direction, air temperature, relative humidity, rainfall, and water level. 40 sites are rainfall only. 74 sites have rainfall and water level. 12 of the 24 meteorological sites are in the Las Vegas Valley. Lake Mead National Recreation area has a network of sites also. New sites are being added in northwest Las Vegas. All data are available on-line at www.ccrfcd.org.



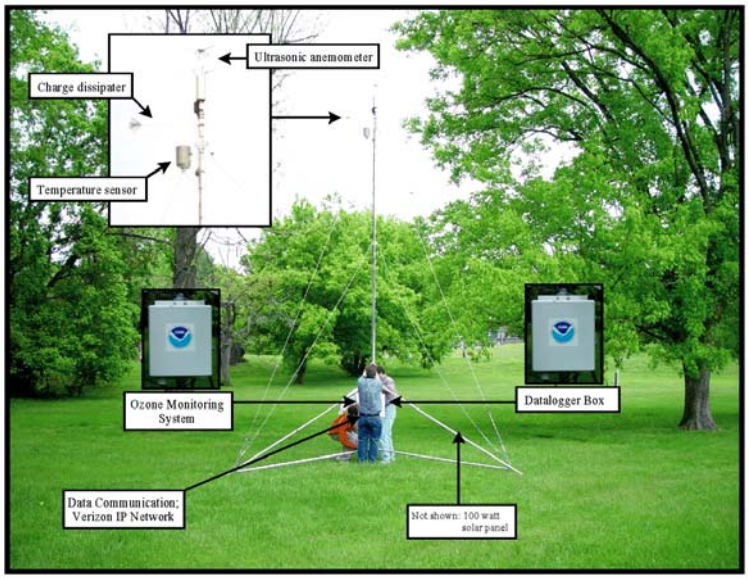
National Weather Service

Stanley Czyzyk gave an overview of modeling activities being conducted by NWS Las Vegas. They will soon be running the ETA model at 4-5 km grid resolution. In the future the Weather Research and Forecasting (WRF) model will be run. A goal is to have high-resolution wind forecasts.

ARL Headquarters

Bruce Hicks presented the urban meteorological test-bed concept that is being developed and applied first in Washington D.C. (DCNet) The test-bed program is to support weather forecasting, air quality, and dispersion for homeland security applications. DCNet will include numerous meteorological sites with chemical sensors to be added later. SODARs will be added at some sites. Modeling uses data from the network to adjust the forecast wind fields. Over the next few years additional urban test-beds will be established. Las Vegas is high on ARL's priority list of test-bed locales. The upper air network being deployed in support of ozone assessment in southern Nevada gives a jump start to establishment of a Las Vegas meteorological test-bed.

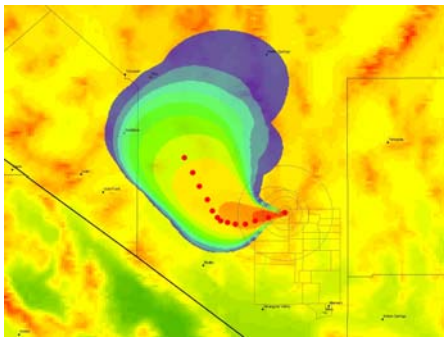
Typical DCNet/UrbaNet tower configuration



Meteorology (surface and upper air) by NOAA (& Army)

Radiation sensors by DHS/EML.

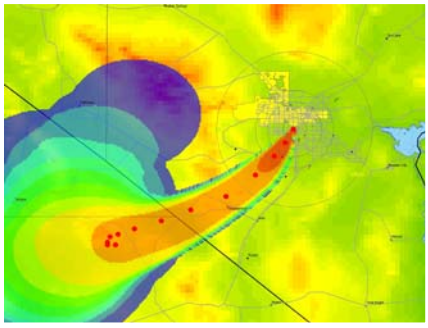
Chemical sensors to be added later.



← In Nevada, the NOAA dispersion forecast system is used to predict susceptible areas following a release into the atmosphere at the Nevada Test Site.

The same system is used to forecast plume dispersion from the Las Vegas strip. →

Note the effects of changing meteorology.

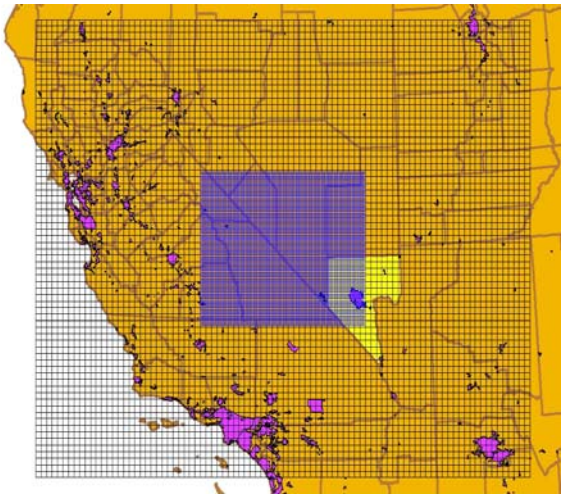


Argonne National Laboratory

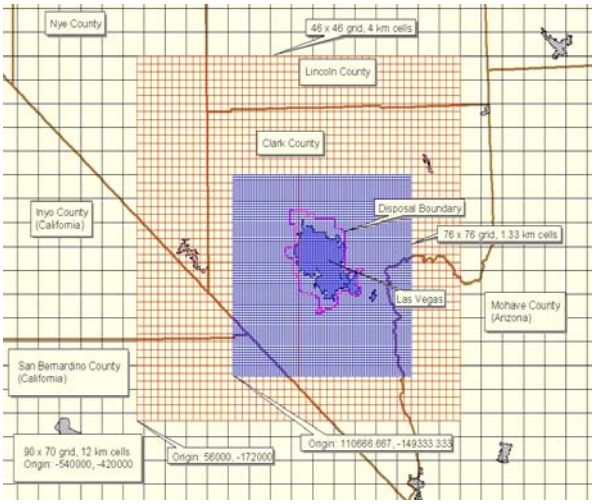
Mike Lazaro gave a presentation on the Las Vegas area ozone and other pollutant species modeling being performed for BLM. The objectives include a comprehensive air quality impact assessment due to growth associated with disposition of Federal lands in southern Nevada. Impacts were modeled for a base year of 2000, and years 2006, 2009, and 2018.

Meteorological modeling is being done with MM5. Emissions data are processed by SMOKE and the Community Multi-scale Air Quality (CMAQ) modeling system is used for the air quality modeling. An outer domain of 1000 x 800 km is done with 12 km grids; inner grids have 4 and 1.3 km grid spacing. Wind data from CCDAQEM were used to nudge the intermediate and inner domain wind fields. Conclusions were that local O_3 production dominated and California contributes 6 to 8% to ozone on high concentration days.

Modeling Domain



Outer Domain (12 x 12 km grids) ~ 1,000 x 800 km



Intermediate (4 x 4 km) 184 km and Inner (1.3 x 1.3 km) ~ 100km Nested Domains

Mike also briefly described work being done by Argonne in support of homeland security, specifically chemical agent incident response.

Comments

Bob Baxter pointed out that private companies have 10 m towers from which data may be available. A private company is operating a SODAR near Jean and data availability should be investigated.

Data needs identified included requirements for better time resolution of information on mixing heights for modeling. Radiosondes could provide this information, but may need many times a day- would be expensive. Radar and SODARS could provide some idea of mixing heights, although the SODARS are limited to a few hundred meters in height.

It was recognized that while multiple meteorological models are routinely run for southern Nevada, little model validation has been done. It would be useful to evaluate the models being run using surface and upper air measurements (soon to be collected). This would be useful for evaluating the utility of different modeling methods and for improving and initializing the promising approaches.

Future collaborative efforts

The participants agreed that there are advantages to future improved coordination and communication of activities. They also agreed that a group should be organized to facilitate cooperation and to promote additional meteorological information generation and sharing to support the goals of the group's participants.

General discussion followed regarding coordinating meteorological data collection, data sharing, and meteorological modeling in southern Nevada. It was agreed that as a first step, an inventory of what data exists and is currently being collected should be completed. A questionnaire will be sent out asking for details on the data being collected – where, when, sampling/averaging period, methodology, etc. A working group was identified to coordinate this effort, including:

Mark Green, CIASTA
Marc Pitchford ARL-SORD
Darryl Randerson, ARL-SORD
Bob Baxter, T & B Systems
Yitung Chen, UNLV
Clark County Dept. of Air Quality and Environmental Management

The data inventory information and other information to facilitate collaboration will posted to the CIASTA web site and e-mails sent to meeting participants and other interested parties as material is added.

In addition, the working group will draft an organizational charge and suggest possible names for the organization.

C. ONGOING EDUCATIONAL/OUTREACH ACTIVITIES

Ongoing educational activities associated with CIASTA researchers includes programs at the University of Nevada-Reno (UNR), University of Nevada- Las Vegas (UNLV), and Nevada State College at Henderson.

University of Nevada-Reno
The graduate (M.S. and Ph.D.) programs in Atmospheric Sciences at UNR are taught by DRI faculty from the Division of Atmospheric Sciences (DAS), most of whom contributed to the current (2001-2006) CIASTA Cooperative Agreement Proposal and many of whom have worked on CIASTA projects.

DAS faculty provide research assistantship support for their graduate students. Graduate research funding sources in addition to NOAA include:

- National Science Foundation
- Environmental Protection Agency
- Department of Energy
- Department of Agriculture
- Federal Aviation Administration
- Department of Transportation
- Department of Defense
- Bureau of Land Management
- EPRI
- Health Effects Institute
- American Petroleum Institute

There are approximately 30 students currently enrolled in the UNR Atmospheric Sciences graduate program. Students focus their research and studies in one of three graduate specialization "tracks" in the Atmospheric Sciences:

Atmospheric Physics -- mountain wave dynamics, cloud and aerosol physics, orographic precipitation, optics and instrument design

Atmospheric Chemistry – air pollution sources and deposition, visibility, biogenic emissions, organic and inorganic composition, dispersion and transport processes, photochemistry, air quality forecasting

Meteorology – numerical modeling, forecasting, weather modification, fire weather, climatology of the western U.S. states

DAS operates a mountain-top research facility, Storm Peak Laboratory (SPL), in the Rocky Mountains of northwestern Colorado (3200 m M.S.L). A University of Nevada graduate field course in Atmospheric Sciences is taught at SPL by DAS faculty. This class is designed to give the students experience in all facets of a field research program, from the development of the research proposal and experiment, through project planning and final reporting. The students proceed through the steps of experimental design for the field site, acquisition and testing of

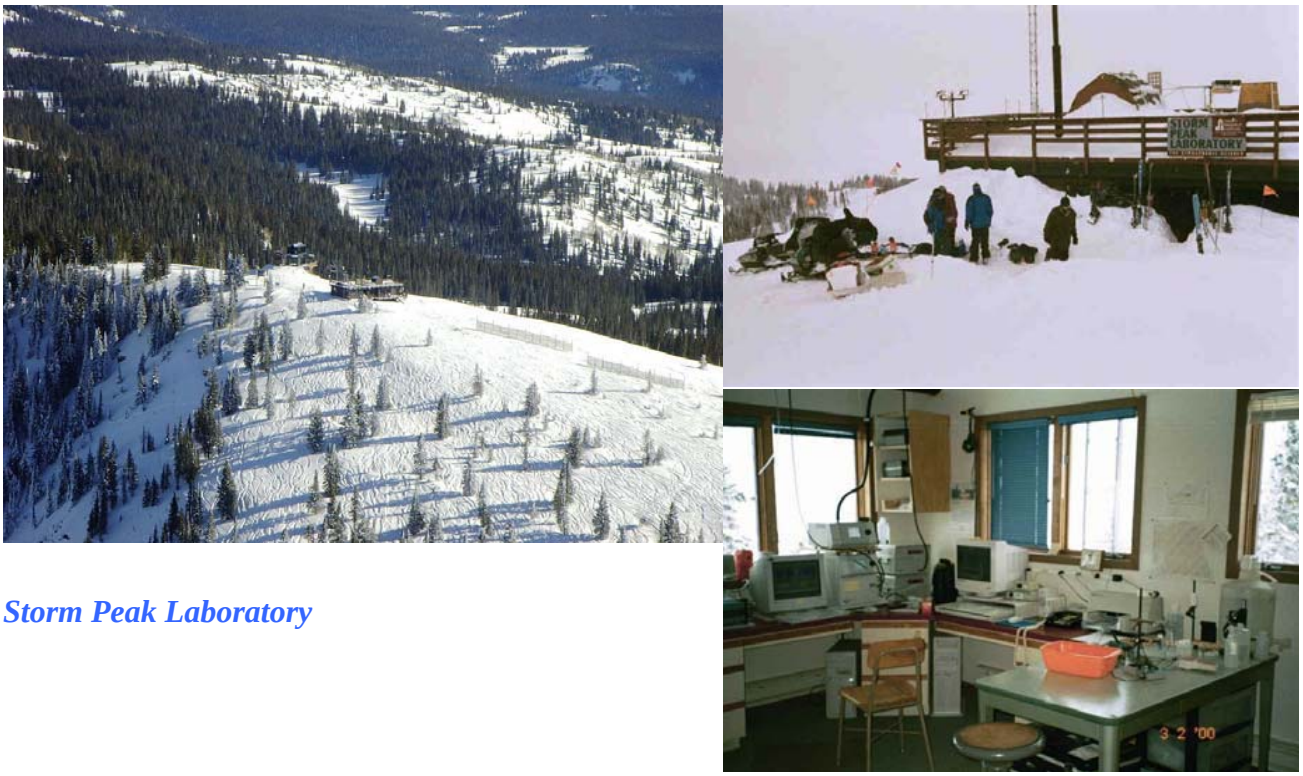
instrumentation, development of data collection procedures, equipment deployment and instrument installation, in-field documentation, data analysis and interpretation, and summary of their results in a written paper and in an oral presentation.

Plans for expansion of the atmospheric science program at UNR include:

Development of a B.S. degree program in Atmospheric Sciences in partnership with the UNR Physics Department (to enhance recruitment into the graduate program and advance research collaborations with UNR faculty in other departments)

Establishment of a Department of Atmospheric Sciences at UNR with joint appointments between UNR (tenure-track) and DRI.

Storm Peak Laboratory is also being used for research on ice nuclei conducted by NOAA scientists.



Storm Peak Laboratory

Nevada State College at Henderson

The CIASTA director teaches 1 class per semester at Nevada State College at Henderson (NSC). NSC is a 2 year old, Minority Serving Institution in the southern portion of the Las Vegas metropolitan area. Classes taught to date include Humans and the Environment (ENV 100) and Meteorology/Climatology (GEOL 117).

A 9 course specialization in Air Quality in the Environmental Science Department at NSC has been accepted in principle. It may be several years before student enrollment is sufficient to implement the program.

University of Nevada- Las Vegas
DAS currently employs 5 undergraduate students from UNLV in support of its research projects. The CIASTA director served as a committee member and provided support for a student who recently received an M.S. in Chemistry from UNLV.

CIASTA teaches an introductory Meteorology course in the Geosciences department. The CIASTA director and another CIASTA funded scientist have proposed a 5 course study in air pollution at the graduate level at UNLV. The Departments of Environmental Studies, Chemistry, and Public Health at UNLV are supporting these proposed courses. One course, "Principles of Air Pollution Science and Management", has been approved; the four other courses will soon be submitted for approval.

In addition to providing relevant training for the students, the students recruited through this effort will provide valuable support for CIASTA and DAS research studies.

Current and Planned Outreach Efforts

Participation in NWS Outreach
DRI Faculty, including CIASTA researchers, have had several Cooperative Program for Operational Meteorology, Education, and Training (COMET) Program Partners and Coop Projects with NWS offices in the Intermountain West (Reno and Grand Junction), and these collaborations are continuing.

Topics of these research projects have included:

- Orographically-forced wind systems
- Snowfall prediction in radar observation-limited mountainous terrain
- Air pollution analysis and forecasting in urban valley environments
- Road weather analysis and forecasting

External funding from NSF, Department of Education and corporate sponsors has been used to bring research experiences and education to diverse groups.

Instructor and Student-Teacher Team Education

- Development of computer-based training modules and summer workshops for college and community college instructors on atmospheric instrumentation, air quality monitoring and water resource measurements, funded by NSF Advanced Technological Education program.
- Teaming of community college instructors with DRI faculty to conduct research on topics such as cloud physics and satellite remote sensing, supported by Eisenhower Grants via the State of Nevada.
- Field studies for high school science students and teachers at field sites such as the Storm Peak Laboratory (studies of UV radiation and ozone climatology), funded by NSF.

School and Field Activities Targeting Students and the Public

- GIS applications to mountain climate variability with sponsorship from Annenberg Foundation

- Science Box distribution to elementary school groups for hands-on exploration of a variety of environmental topics funded by DRI and corporate sponsors

- Renewable energy school education partnership with Sierra Pacific Power Company

- Media stories by Weather Channel, National Geographic, CNN, large-market TV and print, and local radio, TV and newspapers

The CIASTA director is involved with a K-12 science school (Oliver Ranch) in Red Rocks National Conservation Area near Las Vegas. An IMPROVE protocol aerosol monitoring site, surface meteorology, and ozone monitoring is planned to be located on-site. CIASTA will work on development of training materials for K-12 teachers who will visit the Oliver Ranch science school.

D. DISTRIBUTION OF NOAA FUNDING BY TASK

The only NOAA funding received during the period July 1, 2004 – June 30, 2005 was $60,000 for Task I, Administration.

II. Research Reports

TASK II: WEATHER RESEARCH

Reaching the Ground: Developing Sustainable Partnerships between Scientists and Decision-Makers

Project Personnel: Tim Brown
Task: Weather Research
NOAA Goal No. 3: Serve Society's Needs for Weather and Water Information
Objective: The aim of this project is to document the development of the California and Nevada Smoke and Air Committee (CANSAC) in the context of a partnership.

CANSAC is a consortium of nine federal, state, county and local wildland fire and air quality agencies formed to address short-term prediction issues of fire weather, fire danger, fire behavior, smoke dispersion/transport and air quality as related to wildland fire, prescribed fire and fire use. The study focus is on documenting steps and interactions in developing a sustainable partnership between scientific and decision-making communities. CANSAC provides a useful example case of a partnership between wildland fire, air quality and atmospheric science research sectors.

The structure of CANSAC is examined in from a social science perspective of the theory of establishing partnerships. A literature review of social science theory and findings on partnerships has been completed and synthesized. This synthesis provided a necessary framework for developing a formal survey containing questions and statements pertaining to partnership structure, organizational design, availability of resources, CANSAC management, CANSAC leadership, and CANSAC progress. Twenty-one respondents from three CANSAC groups - Board of Directors (BOC), Operational Applications Group (OAG) and Technical Advisory Group (TAG) – participated in the survey.

Overall, the survey results indicate at least a moderate level of satisfaction in terms of a CANSAC partnership. The fact that both BOD and OAG feel strongly that their organizations interests are well integrated into the partnership is an important component. It would be desirable for TAG to have a similar opinion. CANSAC resource issues appear to need improvement, as does the project and product evaluation process. Except for funding, there appears to be no significant breakdown in any category that would seriously impact the partnership. With CANSAC operations effectively only one year old, it can be expected that demands for products will increase, and opportunities to build further on the partnership will be available. CANSAC, at present, can be identified with a number of observed and theorized aspects of synergistic partnership characteristics and determinants, and thus may be a useful model for scientist and decision-maker sustainable partnerships.

TASK III: CLIMATE RESEARCH AND SERVICES

Development of National Indexes for Monitoring Climate Variability Relations to Air Quality

Project Personnel: Kelly Redmond (DRI/WRCC); Kenneth Kunkel (Univ. of Illinois/MRCC); Art DeGaetano (Cornell Univ./NRCC); support staff at Research Climate Centers. At WRCC: Kelly Redmond, Dorothea Ivanova, Greg McCurdy
Task: Climate Research and Services
NOAA Goal No 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond; and
NOAA Goal No. 3: Serve Society's Needs for Weather and Water Information
Objective: Develop quantitative indicators of climatological and meteorological factors pertinent to air quality and investigate relations of such indicators to larger scale patterns of climate variability.

Western Regional Climate Center (WRCC). The WRCC role in this project involves the development of indices based on historical and current radiosonde profiles, such as monthly counts of inversions. We started with a limited period-of-record radiosonde data set and, after a good deal of preliminary data examination, obtained the remainder of the North America radiosonde data set. What we now have is a combination of the Forecast Systems Lab (FSL) version of the data set, and the archived and current version of the National Climatic Data Center (NCDC) data in two different formats (TD6200 and TD6301). Considerable time was spent checking to see how well these data bases agreed. WRCC has an extensive set of software built to process files in TD6200 format but not TD6300, so conversion software had to be prepared. The approach taken was to convert from TD6300 to TD6200 for backward compatibility. This data format conversion turned out to be a rather complex task. Additional software was developed to convert all files into an internal binary format to facilitate future automatic data processing and data analysis. During this process some problems with the new TD6200 files starting with year 1998 were encountered, in the form of undocumented and therefore unexpected differences between the number of levels reported in the records and inaccurate record lengths.
Another set of programs has already been built in WRCC to ingest, decode and convert to the same format the soundings from operational feeds. Modified programs were produced to provide a lister capability, and to produce the inversion counts. Another program was developed to obtain monthly time series and climatological inversion statistics at each station. The next step, in progress, is to be able to portray results on a web-accessible map of North America. The historical station distribution is shown in the figure. Some stations have moved, and they have different periods of record. We have begun to examine the time series for their temporal behavior. First results show unusual behavior in inversion frequency during portions of the data record over the last 30-50 years, especially in the earlier years. These will have to be investigated more closely to determine whether there are systematic changes in the way inversions are portrayed in sounding data. Preliminary comparisons (at seven western states stations) of the different radiosonde data sets (FSL and NCDC) show relatively small

differences, though the data processing pathways have been different. We have learned not to take anything for granted in dealing with these versions of the data sets.

Fig.1. Map of North America and Hawaii with the stations included in the radiosonde data set.

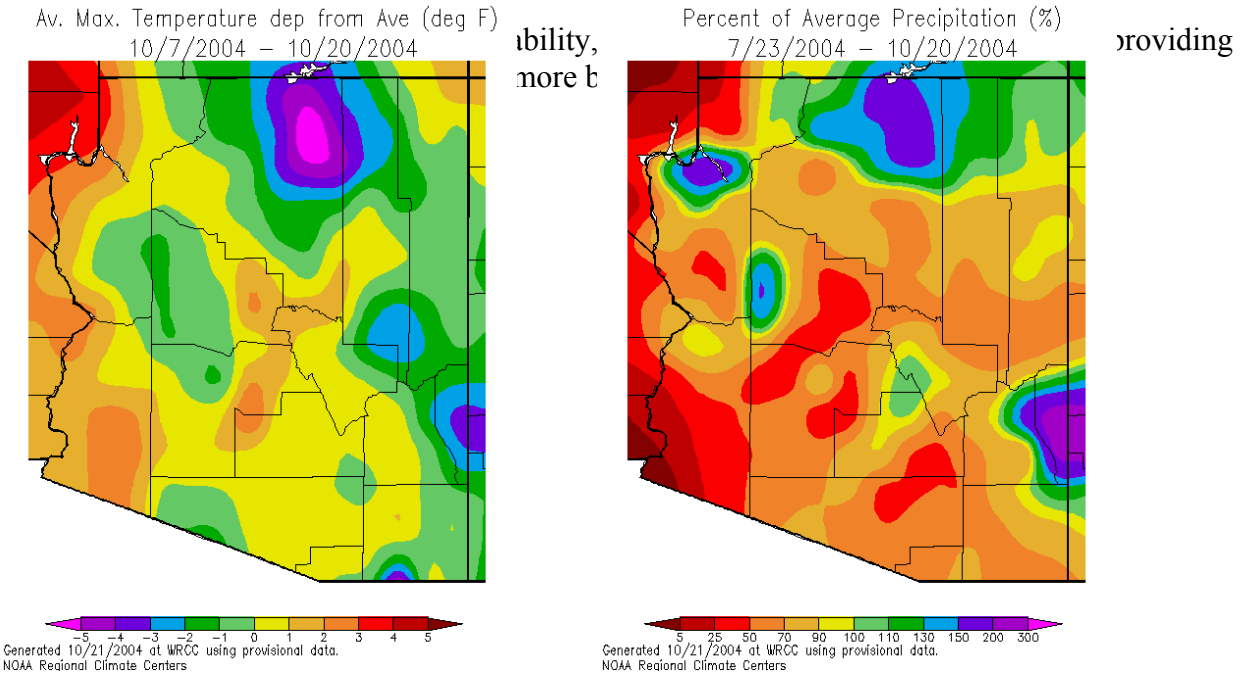
Improved Near-Real-Time Monitoring of the Climate of Arizona and the Southwest

Project Personnel: Kelly Redmond and Greg McCurdy
Task: Climate Research and Services
NOAA Goal No 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond; and
NOAA Goal No. 3: Serve Society's Needs for Weather and Water Information
Objective: The purpose of this project is to portray the existence and status of recent and ongoing climate anomalies in the state of Arizona in forms that can be readily digested by users. We are primarily interested in mapped information, and are concentrating on temperature and precipitation.

The project takes advantage of related efforts to develop the Applied Climate Information System (ACIS), a collective activity among the NOAA Regional Climate Centers. ACIS is currently decoding the daily state temperature and precipitation tables produced by National Weather Service (NWS) Weather Forecast Offices around the United States. This effort therefore also requires coordination with those offices and their respective regional offices. This has resulted in the availability of daily maximum and minimum temperatures and daily precipitation from approximately 600-800 NWS cooperative stations in the 11 western states, and approximately 30-50 each day from the state of Arizona. Though not every station is reported every day, a subset of about 30-40 stations consistently report, or about a third of the total number of stations potentially available. For this process we need stations that have a significant history for which a climatology can be established (20-30 years of record). These are assimilated into a temporary data base in the form of provisional values. We also obtain updates and upgrades beginning a month or two later. At this point a much larger number of stations becomes available, and with a higher degree of quality control. However, the emphasis for this project is on anomalies up until the last day or two (as close to real time as possible), and thus the recent information acts as a limitation on the number of stations.

These are mapped, as both original values and as departures from average. Temperatures (maximum, minimum, and mean daily) are shown in absolute units (e.g., degrees F, in this case). Precipitation is shown in original units (inches), in departures in absolute units (inches minus climatology, over the interval in question), and in percentage of average. We have not yet developed a representation in frequency terms (percentile), though this would be very beneficial. These values are computed for each available station for a variety of durations culminating in the last day: the last 7 days, 14 days, 30 days, 60 days, 90 days, 6, 12, 24, and 36 months, as well as periods starting the current month and season, and other periods of interest (calendar and water year to date, for example), and other periods that users have requested in the past. There are 14 different durations, and 23 different quantities, for a total of 322 maps, shown with and with numbers and values, or a grand total of 644 maps, generated for the state of Arizona every day, and displayed on the web page www.wrcc.dri.edu/anom/ari_anom.html.

This project is funded under the NOAA Climate Assessment for the Southwest (Climas), one of the RISA (Regional Integrated Sciences and Assessments) projects. A group of individuals in



Arizona maximum temperature departure from average for the 14 days from Oct 7-20, 2004 (left) and precipitation departure from average for the 90 days from July 23 through October 20, 2004.

TASK IV: AIR QUALITY RESEARCH

Clark County Ozone Study

Project Personnel: Mark Green
Task: Air Quality Research
NOAA Goal No. 3: Serve Society's Needs for Weather and Water Information
Objective: To better understand occurrences of high ozone levels in the Las Vegas Valley. Parts of Clark County Nevada in and near the Las Vegas metropolitan area have been designated by the USEPA as being not in attainment of the Federal 8-hour ozone standard.

The field portion of the study was conducted from May through August 2005 and had several key components:

1) Deployment of additional ozone monitors in and near the documented high concentration area to better define the location of maximum ozone concentration;
2) Deployment of additional ozone monitors south and southwest from Las Vegas to document transport of ozone from outside the non-attainment area;
3) Measurement of volatile organic compounds and oxides of nitrogen (key components in formation of ozone) at upwind, central city, and downwind (high concentration site);
4) Measurements of winds aloft using a radar wind profiler (RWP) and SODARs a 4 locations;
5) processing of NEXRAD weather radar data to obtain winds aloft at additional locations surrounding the study area.

Results of the study will be used to provide input to air quality models for ozone and will also be used to formulate conceptual models of the relationships between local and transported air pollution and meteorology on ozone concentration patterns in southern Nevada.

CIASTA role in the study

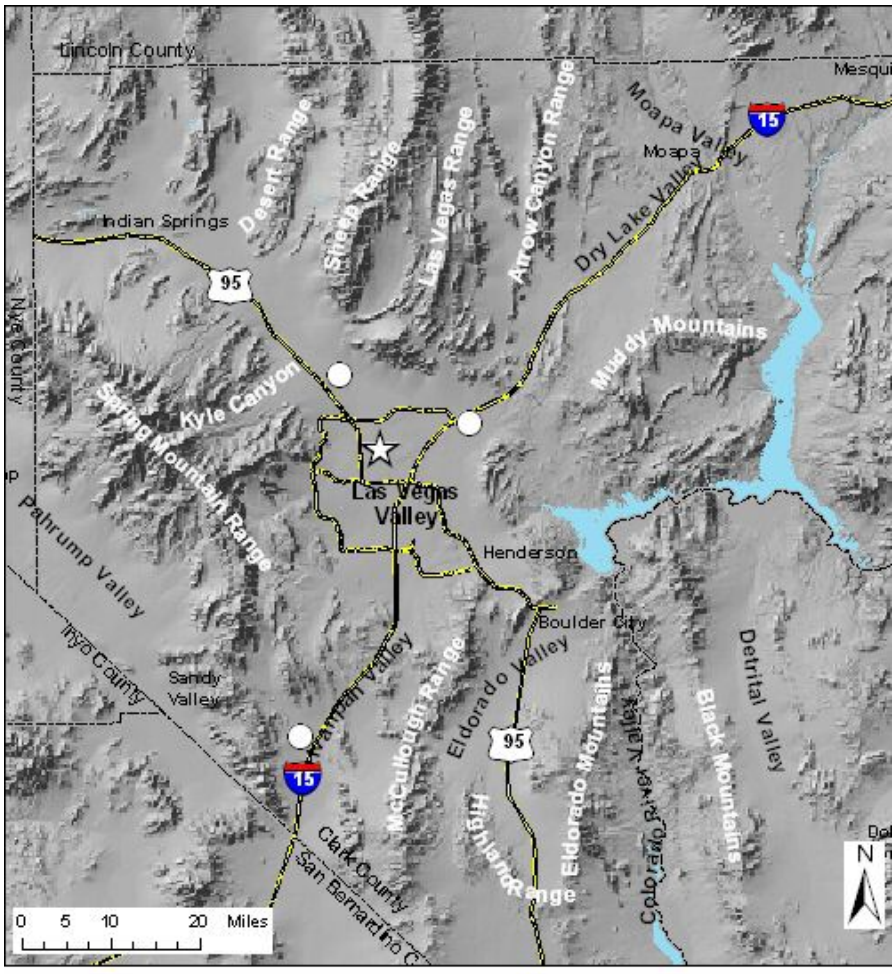
CIASTA is responsible for:

- Purchasing the RWP and SODARs;
- Establishing monitoring sites for locating the instruments;
- Collection and quality assurance of the data;
- Data analysis and interpretation of the upper air data ;
- Processing the NEXRAD data from Las Vegas, Cedar City, Yuma, and Edwards Air Force Base to provide hourly upper level winds surrounding the study area;
- Providing additional radiosonde and pilot balloon (pibal) releases, including data collection, QA, archival, and interpretation (NOAA's Air Resources Laboratory will perform this function);
- Collect and analyze air samples for Volatile organic compounds;
- Operate ozone monitors and QA data for the Mojave National Preserve site in California and the Desert Rock site northwest of Las Vegas.

Fixed upper air monitoring sites include:

- North Las Vegas airport (mini-SODAR and RWP)
- Las Vegas motor speedway (SODAR)
- Jean, NV (SODAR)
- Floyd Lamb State Park northwest Las Vegas (SODAR)

Site locations are shown in the Figure below.



○ **Sodar sites**

☆ **Radar wind profiler and collocated minisodar**

Radiosondes were released at each fixed site for quality assurance of the RWP and SODARs and at additional locations of interest to document local flow patterns and their diurnal variation.

Study sponsors and participants:

The study is funded by the Clark County Dept. of Air Quality and Environmental Management and the US Environmental Protection Agency.

Participants include:

T & B Systems

The Cooperative Institute for Atmospheric Sciences and Terrestrial Applications (CIASTA) which includes participation by:

- National Oceanic and Atmospheric Administration Air Resources Laboratory
- Desert Research Institute

University of California Riverside

As of September 2005, participants are readying their data for use in data analysis activities and future air quality modeling.

TASK V: TERRESTRIAL ECOSYSTEMS AND CLIMATE

Evaluation of the Atmospheric, Soil, and Plant Community Parameters that Influence Surface Water Balance and the Relationship to Waste Disposal

Project Personnel: William Albright, Brad Lyles (DRI/DHS); Craig Benson, Preecha Apiwantragoon (Univ. of Wisconsin/Madison); Tarek Abichou (Florida State University)
Task: Terrestrial Ecosystems and Climate
NOAA Goal No. 3: Serve Society's Needs for Weather and Water Information
Objective: The goal of the ACAP program for the period July 1, 2003 through June 30, 2005 was to collect, QA, and analyze data from the ACAP field sites. In addition, each site required an annual site visit to calibrate instrumentation, collect additional samples and to verify proper operation of the site.

Results: Data were collected from each of the ACAP sites throughout the year. The exception was at the Albany GA site which was decommissioned in preparation for installation of the fullscale cover. All field data were checked for quality assurance and made available for further analysis. Each site was visited for the annual maintenance and sampling visit. One paper on the overall program results was published in the Nov-Dec 2004 edition of the Journal of Environmental Quality. Several conference presentations were made and three short courses were taught by program personnel based on data derived from the program.

III. Appendix

A. PUBLICATIONS

Andsager, K., T. Ross, M.C. Kruk, M.L. Spinar, 2004: CDMP: pre-20th Century Task - Key Climate Observations Recorded Since the Founding of America, 1700's-1800's, Preprint Volume: *14th Conference on Applied Climatology*, American Meteorological Society, Seattle, Washington, paper 7.7, 9 pp.

Burroughs, J. and S.A. Changnon, 2003: The Tri-State Hailstorm: The Most Costly on Record. *Midwest Extreme and Hazardous Weather Regional Conference*, Champaign, IL, October 17-18, 2003.

Cayan, D.R., M.D. Dettinger, K.T. Redmond, G.J. McCabe, N. Knowles, and D.H. Peterson, 2003: The transboundary setting of California's water and hydropower systems. Chapter 10, p. 237-262, In Climate and Water: Transboundary Challenges in the Americas, eds H.F. Diaz and `EB.J. Morehouse, Kluwer Academic Publishers, 424 pp.

Changnon, S.A., and S.E. Hollinger, 2003: Potential Impacts of Future Climate Change on Midwestern Corn Yields. *Climate Change* **58,** 209-228.

Changnon, S.A., J.R. Angel, K.E. Kunkel, and C.M. Lehmann, 2004: *The Illinois Climate Atlas*. Illinois State Water Survey Information/Education Material 2004-2, 309 pp.

Changnon, S.A., and J. Burroughs, 2003: Temporal Behavior of the Levels of Middle and Upper Great Lakes Reveals Major Space and Time Climate Differences during 1861-2001., 2003 Illinois State Water Survey, Champaign, IL , v, 29 p.Changnon, Stanley A., Burroughs, Jonathan. 2003. The Tristate Hailstorm: The Most Costly on Record. *Monthly Weather Review*: **131**(8), 1734+1739.

DeGaetano, A.T., and M.J. O'Rourke, 2004: A climatological measure of extreme snow drift loading on building roofs. *J. Appl. Meteorol.,* **43**, 134-144.

DeGaetano, A.T., and O.M. Doherty, 2004: Temporal, Spatial and meteorological variations in hourly PM2.5 concentration extremes in New York City. *Atmospheric Environment*, **38**,1547-1558.

Dettinger, M.D., K.T. Redmond, and D.R. Cayan, 2003: Orographic-precipitation gradients associated with winter storms in the Sierra Nevada: Climatic underpinnings and hydrologic consequences. *28th Annual Climate Diagnostics and Prediction Workshop*, Nugget, Sparks Nevada, Oct 20-23, 2003. 162.

Hilberg, S.D., 2003: The Synoptic Weather Conditions Associated with the Heavy

Thunderstorms of August 2002 in the Midwest. Preprint, *Midwest Extreme and Hazardous Weather Regional Conference*, Champaign, IL, October 17-18 2003.

Hodges, L., M.N. Suratman, J.R. Brandle, and K.G. Hubbard, 2004: Growth and yield of snap beans (Phaseolus vulgaris L.) as affected by wind protection and microclimate changes due to shelterbelts and planting date. *HortScience,* **39**(5), 996-1004. (13169)

Hou, Q, J. Brandle, K. Hubbard, M. Schoeneberger, C. Nieto and C. Francis, 2003: Alteration of soil water content consequent to root-pruning at a windbreak/crop interface in Nebraska, USA. *Agroforestry Systems*. **57,** 137-147. (13395)

Hubbard, K.G., A.T. DeGaetano, and K. Robbins, 2004: A Modern Applied Climate Information System. *Bull. Amer. Met. Soc*., **85**(6).

Hubbard, K.G., and X. Lin, 2003: Air temperature errors caused by air filter and conduction effects on HMP45C temperature sensors in weather stations. *Trans. ASAE*. **46**(2), 443-452. (13208)

Hubbard, K.G., X. Lin, K. Robbins, R. Fontenot, and C.B. Baker, 2003: Preliminary Results from a Field Comparison of Relative Humidity Sensors. The *12th Symposium on Meteorological Observations and Instrumentation.* 14.2. The AMS 83 Annual Meeting, Long Beach, CA.

Huggins, A. W., D.E. Kingsmill, and S. Keck, 2003: Summary of wintertime QPE results from a new VPR-based algorithm for the WSR-88D. Presentation at *10th Annual Intermountain Weather Workshop*, Reno, NV, November, 2003.

Janis, M. J., K.G. Hubbard, and K.T. Redmond, 2004: Station Density Strategy for Monitoring Long-Term Climatic Change in the Contiguous United States. *J. Climate,* **17**(1),151-162.

Janis, M.J., K.E. Kunkel, A.T. DeGaetano, L.C. Harrington, C.J. Westbrook, T. Lavin, and A. Nelson, 2004: Development of Climate Indices for Monitoring Vectors of West Nile Virus. *Preprints, 14th Conference on Applied Climatology*, American Meteorological Society, Boston, MA., 5 pps.

Kruk, M.C, and M.L. Spinar, 2003: May 4, 2003 Severe Weather Outbreak: An In-Depth Overview, Midwestern Regional Climate Center Website, http://mrcc.sws.uiuc.edu/html/historical/may0403svrwx.htm

Kunkel, K.E., D.R. Easterling, K. Hubbard, K. Redmond, K. Andsager, M. Kruk, M. Spinar, 2004: Quality Control of pre-1948 Cooperative Observer Network Data, Preprint Volume: *14th Conference on Applied Climatology*, American Meteorological Society, Seattle, Washington, paper 7.6, 8 pp.

Kunkel, K.E., D.R. Easterling, K. Redmond, and K. Hubbard, 2003: Temporal Variations of Extreme Precipitation Events in the United States: 1895-2000, *Geophys. Res. Lett.*, **30**, 1900, 10.1029/2003GL018052

Kunkel, K.E., and S.A. Changnon, 2003: Climate Years in the True Prairie: Temporal fluctuations of ecologically critical conditions. *Climatic Change*. **61,** 101-122.

Kunkel, K.E., D.R. Easterling, K.T. Redmond, and K.G. Hubbard, 2004: Temporal trends in frost-free season in the United States: 1895-2000. *Geophys. Res. Lett.,* **31**, L03201, Feb 2004, doi:10.1029/2003GL018624.

Lin, X., and K.G. Hubbard, 2004: Sensor and electronic biases/errors in air temperature measurements in common weather networks. *J. Atmos. and Oceanic Technology*, **21**(7), 1025:1032. (14228)

Lin, X., and K.G. Hubbard, 2004: Uncertainties of derived dew point temperature and relative humidity. *J. Applied Meteorol*., **43**(5), 821-825. (14227)

Magnuson, J.J., J.T. Krohelski, K.E. Kunkel, and D.M. Robertson, 2003: Wisconsin waters and climate: Historical changes and possible futures. *Transactions, Wisconsin Academy of Sciences Arts & Letters*. **90,** 23-36

Mahmood, R., and K.G. Hubbard, 2004: An analysis of long-term simulated soil moisture data for three land uses under contrasting hydroclimatic conditions in the Northern Great Plains. *J. Hydrometeorology*, **5**, 160-179. (13534)

Mahmood, R., and K.G. Hubbard, 2004: Simulating sensitivity of soil moisture and evapotranspiration under heterogeneous soils and land uses. *J. Hydrology*, **280**,72-90. (13815)

Mahmood, R., K.G. Hubbard, and C. Carlson, 2004: Modification of growing-season surface temperature records in the Northern Great Plains due to land-use transformation: verification of modeling results and implication for global climate change. *International J. Climatology*, **24**, 311-327. (14621)

McCabe, G.J., M.A. Palecki, and J.L. Betancourt, 2004: Pacific and Atlantic Ocean Influences on Multidecadal Drought Frequency in the United States. *Proceedings of the National Academy of Sciences*, **101,** 4136-4141.

Mitchell, D., A. Huggins, and V. Grubišić, 2004: A new snow growth model with application to radar precipitation estimates. *14th International Conf. on Clouds and Precipitation*, ICCP and IAMAS, Bologna, Italy, 313-316.

Mitchell, D.L., D. Ivanova, B. Hall, M.F. Lavin, D. Gochis, and K.T. Redmond, 2004: Predicting the onset of the North American monsoon and progress toward a mechanistic understanding. *American Meteorological Society, Annual Meeting*, Jan 11-15, 2004, Seattle WA.

National Seasonal Assessment Workshop: Report. Feb 2004. Published by: Climate Assessment Project for the Southwest (CLIMAS) Institute for the Study of Planet Earth. The

University of Arizona Tucson, Arizona. USFS Conference. January 27-29, 2004. National Conservation Training Center, Shepherdstown, WV.

O'Rourke, M.J., A.T. DeGaetano, and J.D. Tokarczyk, 2004: Water flume simulation of snow drifting., *Journal of Wind Engineering and Industrial Aerodynamics.* [In review].

Palecki, M.A., and J.R. Angel, 2003: The 2002-2003 *Snow Drought in the Upper Midwest. AMS* Midwest Extreme and Hazardous Weather Regional Conference, Champaign, IL, October 17-18, 2004.

Pitchford, M.L., I.H. Tombach, M. Barna, K.A. Gebhart, M.C. Green, E. Knipping, N. Kumar, W.C. Malm, B. Pun, B.A. Schichtel, and C. Seigneur, 2004: Big Bend Regional Aerosol and Visibility Observational (BRAVO) Study Final Report. Available at http:vista.cira.colostate.edu/improve/.

Rand, P.W., M.S. Holman, C. Lubelczyk, E.H. Lacombe, A.T. DeGaetano, and R.P. Smith, 2004: Thermal accumulation and the early development of Ixodes scapularis. *J. of Vector Ecology*, **29**(1), 164-176.

Robbins, K., 2003: Climate Database Management System. 6-page color brochure prepared for the World Meteorological Organization (WMO), World Climate Programme. Geneva, Switzerland.

Schichtel, B.A., K.A. Gebhart, M.G. Barna, W.C. Malm, D.E. Day, S. Kreidenweis, and M.C. Green, 2004. Big Bend Regional Aerosol and Visibility Observational (BRAVO) Study Results: Air Quality Data and Source Attribution Analyses Results from the National Park Service/ Cooperative Institute for Research in the Atmosphere. Colorado State University CIRA, Ft. Collins, CO.

Suyker, A.E., S.B. Verma, G.G. Burba, T.J. Arkebauer, D.T. Walters, and K.G. Hubbard, 2004: Growing season carbon dioxide exchange in irrigated and rainfed maize. *Ag. and Forest Meteorol*. **124**, 1-13. (14200).

Westcott, N.E., 2003: Conditions associated with dense fog in central Illinois. Preprint, *Midwest Extreme and Hazardous Weather Regional Conference,* Champaign, IL, 17-18 October 2003, 5p.

Westcott, N.E., 2004: Synoptic conditions associated with dense fog in the Midwest. Preprint, *14th AMS Conf on Applied Climatology*, Seattle, WA, 12 -16 Jan 2004. Amer. Meteor. Soc., Boston, 6p.

Westcott, N.E., and S.A. Changnon, 2003: Heavy rainstorms in Chicago: Frequency and Impacts. Preprint, *Midwest Extreme and Hazardous Weather Regional Conference*, Champaign, IL, October 17-18 2003, 5p.

Westcott, N.E., S.E. Hollinger, and K.E. Kunkel, 2004: Relationship between normalized corn yields and monthly rainfall for the Midwestern United States. Preprint, *14th AMS Conf on*

Applied Climatology, Seattle, WA, 12 -16 Jan 2004. Amer. Meteor. Soc., Boston, 5p.

Winstanley, D., and K. Kunkel, 2003: Mother Nature - Friend or Foe? *Outdoor Illinois*, September, 16-19.

Wu, Hong, K.G. Hubbard, and D.A. Wilhite, 2004: An agricultural drought risk-assessment model for corn and soybeans. *Internat. J. Climatology*, **24**, 723-741. (14115)